

## **Appendix 4**

### **Clark Fork River Flows Over Various Averaging Periods**

As noted in Chapter 6, in trying to understand the significance of the existing hydropower water rights in the lower Clark Fork basin and their implications for future basin water rights and for water users with rights junior to the hydropower rights, the Task Force examined flow analyses conducted by two of its members. These analyses did not reach the same conclusions. The Task Force did not endorse either. The following is a summary of the two analyses.

#### **Analysis Presented by Representative Verdel Jackson**

Rep. Jackson considered information about water use and flows and state statutes to determine if Avista's hydropower water rights present a problem for existing and future water use in the basin. He concluded that one cannot demonstrate now that the Avista rights present a problem for the Clark Fork River basin and especially the Flathead sub-basin. The factors he considered and his analysis of them include the following.

##### Existing Basin Water Resources

The sub-basin has abundant surface and groundwater resources. The Flathead drainage has 3,500 miles of streams and 450 lakes, including Flathead Lake. The usable water in Flathead Lake is 1,700,200 acre-ft. The total volume is estimated to be 20 to 25 million acre-ft. Hungry Horse Reservoir has 3,467,179 acre-feet of usable water storage. The abundance of this water provides recharge to the groundwater and most likely is the reason that the Montana Bureau of Mines and Geology (MBMG) has found no decrease in the water table as a result of groundwater development to date. The capacity of groundwater for development is not known, but is considered to be extremely large compared to the small amount of water being used for development each year.

##### Bad Data and Data Gaps

The existing data base on water appropriations and use cannot be used to demonstrate that all of the water has been allocated in the Flathead sub-basin because of missing and duplicate data. Chapter 3 of this plan states, "Information describing existing appropriations of water represents the most significant gap in information and knowledge required for basin planning and management.... As a whole it cannot be considered to be accurate, consistent, and reliable." The problems with these data include:

- \$ The failure of existing water appropriations to specify consistently the period of use.
- \$ The rate and volume are not separated by use for each water right identification number. For a given identification number, either a rate or a volume were commonly found, but not both.
- \$ Multiple entries for an identification number were found approximately 43% of the time.
- \$ Priority dates were missing in some cases.

Also, in the water rights data, consumptive uses are not separated from non-consumptive uses. Non-consumptive uses dwarf consumptive uses. Less than 1 million acre-feet in 76LJ (Flathead River) are allocated to consumptive uses, while more than 7 million acre-feet are allocated to non-consumptive uses, primarily fisheries. Nearly all of the consumptive use on the South Fork lies in an irrigation right held by USBR, which has not been utilized. Also, correlation between allocation and actual use or depletion is unknown. With consumptive uses, return flows are not considered. For example, based on records of water use by the City of Kalispell, the return flow from domestic use is between 70 and 73%. With irrigation the return flow is generally believed to be 44% to 50% but could be much higher. In the case of non-consumptive uses, the return flow is generally 100%. These data problems and data gaps prevent one from demonstrating that existing water uses have consumed the available surface or groundwater in the Flathead sub-basin. Measuring the actual flow of water in the rivers over a long period of time is likely the

most accurate measure of water depletion resulting from water uses. USGS has been doing this for 92 years. Presently, the volume of water used by junior water right holders is unknown.

#### Implication of Basin Water Use for Avista's Water Rights

As of June 2, 1998, Montana's Centralized Water Right Records System identified 26,274 surface water uses for the Clark Fork basin. Thirty percent of these were junior to the most senior water right at Noxon Rapids Dam (35,000cfs with a 1951 priority date). Only 3,125 uses are junior to the most junior Noxon Rapids water right (15,000 cfs with a 1976 priority date). The uses of the water rights junior to Avista's as of June 2, 1998, by number were: 40% irrigation, 32% municipal, 16% stock water, and 12% unknown.

The impact of total basin irrigation on water available to Avista at its Noxon Rapids project is estimated in the following table. Average yearly flow of Clark Fork River near Plains is 14,567,770 acre-feet (45 year average).

Table A4-1					
Total Basin Acres Irrigated	Water Allotted	Average Used	Average Consumed	Depletion	Percent of Annual Flow
470,000 ac	X 2.5 ac/ft	X .67	X .56	= 440,860 ac/ft	3.03%
428,000 ac	X 2.5 ac/ft	X .67	X .56	= 401,464 ac/ft	2.76%
411,000 ac	X 2.5 ac/ft	X .67	X .56	= 385,518 ac/ft	2.65%

Thus, using three different estimates of the basin's irrigated acreage, basin irrigation consumes between 2.65% and 3% of the average annual river flow at Plains. Irrigation has traditionally been the largest water user. As is seen in Table A4-2, the growth in irrigation from 1950 to 1980, using data from the 1983 Depletion Task Force Report, consumes only about 0.44% of the average annual flow of the Clark Fork River near Plains.

Table A4-2						
	Total Acres Irrigated	Water Allotted	Average Used	Average Consumed	Average Depletion	Percent
Prior to 1950	358,000 ac	X2.5 ft/ac	X.67	X.56	= 335,000 ac/ft	2.3%
1950-1980	69,000 ac	X2.5 ft/ac	X.67	X.56	= 64,000 ac/ft	0.44%
Total	427,000ac	X2.5 ft/ac	X.67	X.56	= 400,526 ac/ft	2.75%

However, this figure is overstated because when the irrigated acreage was compiled, the irrigated acres were double counted in the reservoir records and change of use authorizations. According to the Cunningham Report, between the years of 1950 to 1980 the additional water use was 60,600 acre-feet, which is 0.4% of the average annual flow in acre-feet at Noxon Rapids. The Cunningham Report further concluded: "In the early 1950s Hungry Horse Dam was completed and has provided flow benefits to WWP (Avista) at both Noxon Rapids and Cabinet Gorge Dams. It can be argued that these modified flow releases from Hungry Horse dam have mitigated any power losses that would have occurred from increased irrigation depletions in the Flathead." Because additional development of irrigated acreage in the basin is very small, the development will not have an adverse impact on Avista's hydropower water supply. Also, agricultural land is being converted to residential and commercial use at a very high rate.

#### Historic River Annual Average Flow Data

USGS data on historic annual average river flow at Polson, St. Regis, and Plains are shown below in Tables A4-3, A4-4, and A4-5, respectively. These data show that the 45-year average river flow since Avista built its hydroelectric dam at Noxon is higher than the preceding 45-year average. This is true at all

three water measuring sites: Polson, St. Regis and Plains. Also, the average for the last 10 years at each site is higher than the average for the last 45 years. There is no evidence from the annual water flow data for the Flathead River and the Clark Fork River that the water supply for Avista has been adversely affected by increased water use. The depletion is actually very small compared to the total water available

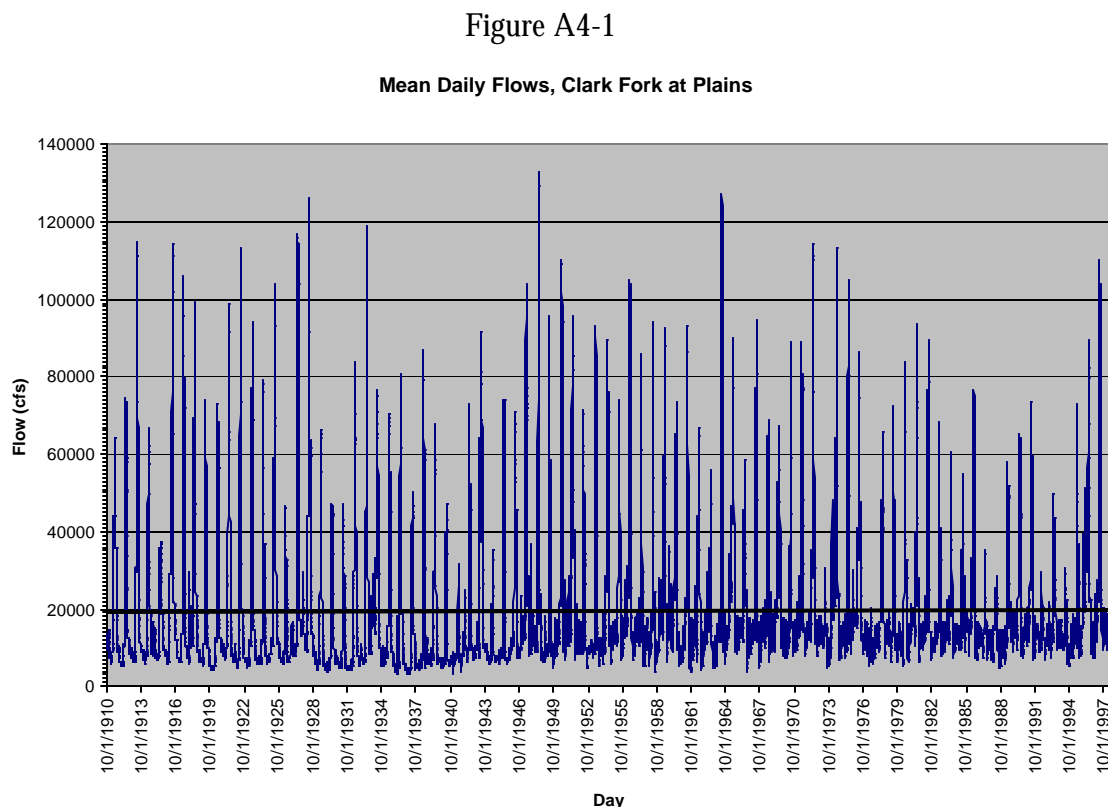
#### Historic River Monthly Average Flow Data

Table A4-6 shows the monthly average flows in the Clark Fork at Plains, again based on USGS data. Mr. Jackson noted that the 45-year monthly average flows since construction of the Noxon Rapids Dam, i.e. 1956-2000, is higher for January through April and September through December than for the 45 years preceding the dam, 1911-1955.

Thus, using monthly flow data, Rep. Jackson concluded that no measurable negative impact on Avista's water rights occurs as a result of farm and ranch land irrigation during the summer months or at any other time. The use of storage behind Hungry Horse Dam and in Flathead Lake also has been of great benefit to Avista.

#### Historic River Daily Average Flow Data

Figure A4-1 shows the USGS data on daily flows at Plains for 1910-1997.



Rep. Jackson found that over an 86-year period, the average daily flow of the Clark Fork River at Plains is a straight line, 20,000 cfs. This data from the USGS water measuring station indicates that the amount of water used by increased irrigation and increased consumption by other water users has not had a measurable impact on the amount of flow that is available to Avista (built in 1950) to generate electricity. However, the average flow by month has changed dramatically because of the operation of Hungry Horse Dam (built in 1955). In general, Hungry Horse Dam has redistributed the water from high flow months (May, June and July) to the other lower flow months. This operation enables Avista

to use 703,277 acre-feet that would have been spilled because the flow rate was in excess of 50,000 cfs turbine capacity. This amount is about 6.5% of the yearly average flow of the Clark Fork River.

Figures A4-2 and A4-3 show the total data available (92 years) for the Clark Fork River at Plains divided into two parts. The first period is before Hungry Horse Dam was built and the second half was after. The 86-year chart on the previous page did not contain 92 years of data because it exceeding the capacity of Excel. The top and bottom charts here show that the water flow was average for the first 5 years and then drifted down for 38 years and then was above average for 22 years, average for 7 years, and then has drifted down for 14 years. These short-term trends are likely the result of precipitation. Short periods of time are not dependable for predictions.

Figure A4-2

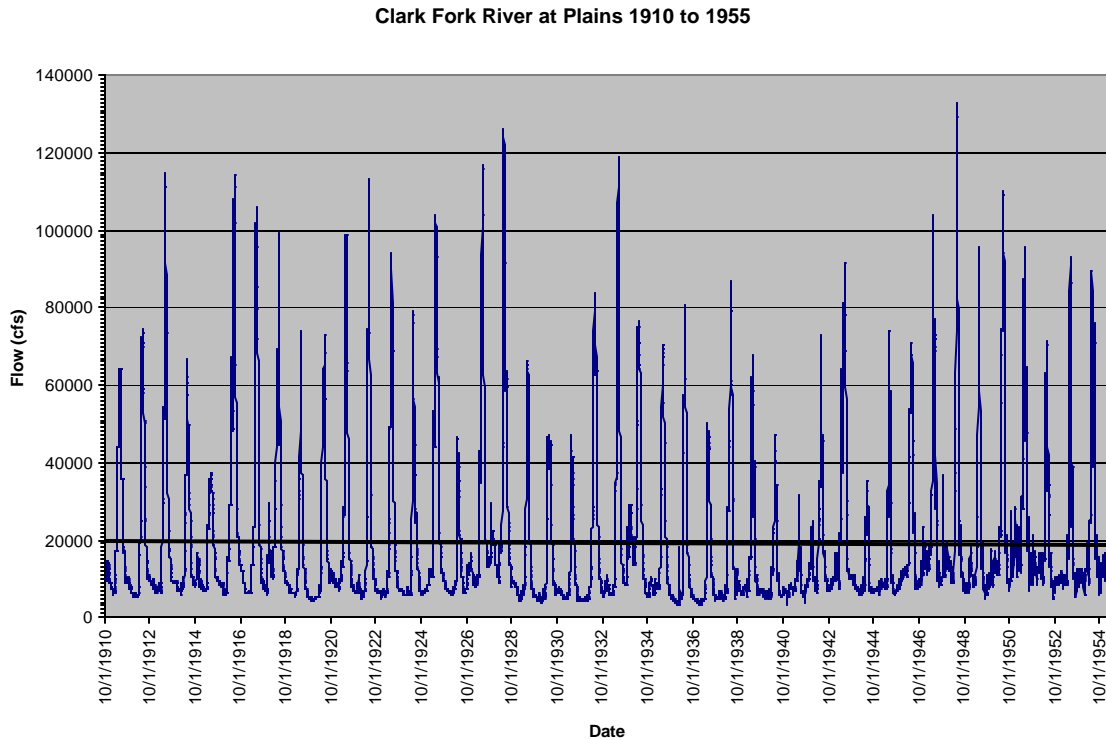
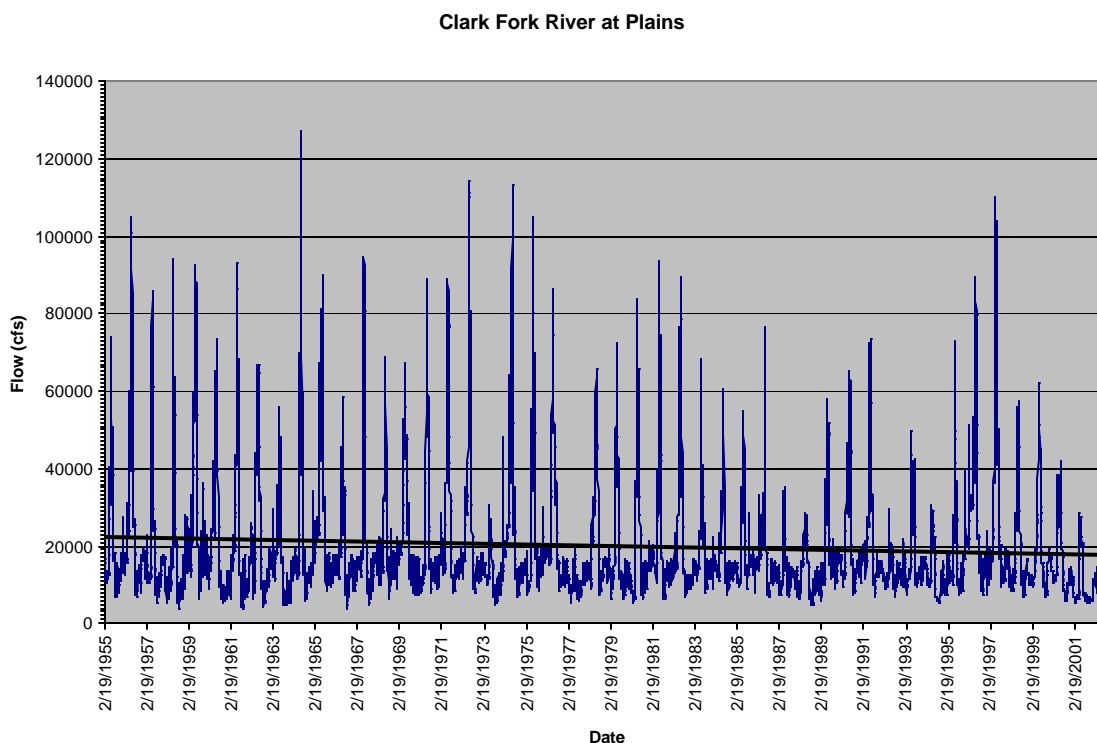


Figure A4-3



Monthly averages mitigate high water flows during the month and therefore underestimate the rate of water flow into Avista on a daily basis. Since Avista has minimal storage capacity, it is considered to be a “run of the river” electricity generation facility. An analysis of the water flow from 1911 to 2000 reveals that water flows into Avista exceeds its capacity to generate (50,000 cfs during April, May, June and July), thus resulting in spills. Spills happen about 9 out of every 11 years or 82% of the time.

Based on 45 years of daily water flow data on the Clark Fork River before the Hungry Horse dam was built, Avista would have spilled an average of 1,592,322 acre-feet per year. (Spills computed on a monthly average basis are 1,220,953 acre-feet per year). Almost all of the spillage occurs during May and June.

After Hungry Horse was built in 1955 and began operating, calculations show that only 878,786 acre-feet per year of water was potentially spilled because the combination of Hungry Horse and Flathead Lake storage reduced river flows during the normal high runoff months and redistributed them over the lower flow months. Specifically, depending on how it manages its own Noxon Rapids’ storage, Avista should be able to utilize for power production an additional 713,536 acre-feet per year spread over the 8 months of lower flows.

During the last 10 years, the operation of Hungry Horse has taken even more of the peak runoff during May and June and added it to the flows in August, November, and December. The average spillage for the last 10 years has now been decreased to 670,948 acre-feet per year, which increases the average amount available per year to Avista up to 921,374 acre-feet. This amounts to about 6.5 % of the average flow of the Clark Fork River at Plains (14,234,467 acre-feet). Thus, the management of the water flow by Hungry Horse Dam has enabled Avista to utilize 921,374 acre-feet, which is more than twice the amount of water depletion used for all irrigation (400,526 acre-feet).

Based on data from the 1983 Depletion Task Force Report, 69,000 acres were converted to irrigation between 1950 and 1980. These irrigators would be junior water users to Avista’s 1950 water right and

subject to a call by them. The water depletion attributed to these junior users is estimated to be 64,000 acre-feet. See table A4-2. This amount of increased water use by irrigators since 1950 is a meager 7% of the extra water Avista is able to utilize as a result of the water management by Hungry Horse Dam.

Analysis of the Likelihood of a Call on Junior Water Users or a Basin Closure to New Water Rights

Avista should NOT make a call on junior water users or push for a basin closure to new water rights for the following reasons:

1. The operation of Hungry Horse dam has totally mitigated the impact of irrigation on water available to Avista for the present and the future. The total amount of irrigated land in the Clark Fork River basin is estimated to be between 411,000 and 470,000 acres. The water consumed to irrigate this much land would be less than half of the extra water made available by Hungry Horse Dam.
2. Although Avista has a right according to Montana water law to make a water call on junior water users, it must also prove that the water will arrive at Avista in sufficient quantities at the right time to have a measurable impact on its production of electricity.
3. The timing of irrigation occurs when the most water is available. The winter run off starts late in April, peaks in May or June, and ends early in July. Irrigation starts early in May, tapers off in August, and ends in September. Irrigators take most of their water during high flows, and about half of that water returns to the river during late summer and fall. It is very likely that irrigators consume a portion of water and also store a portion of water in the ground that would have spilled at Avista during May and June. Later in the summer and during the fall a portion of the groundwater returns to the river and is utilized by Avista.
4. Most of the irrigation water rights are senior to Avista's 1950 senior water right of 35,000 cfs. The only irrigation water rights in danger of a call by Avista would be those with a priority date after 1950. The number of water rights that are junior to Avista's 1976 water right of 15,000 cfs is 3,125 out of a total of 26,274 water rights. The amount of water consumed by these junior water users would be very difficult to determine. The make up of the junior water rights is 40% irrigation, 32% municipal, 16% stock, and 12% unknown. The number of irrigated acres added between 1950 and 1980 is estimated to be 69,000. The amount of water involved to irrigate that much land would be less than 0.5 % of the total water available from the Clark Fork River and would not be measurable at the Avista facility. In fact, 5% would be difficult to measure considering the unpredictable operation of Hungry Horse Dam, Kerr Dam, and Avista's facilities.
5. There are many characteristics of Avista's water right that indicate that the water right was crafted to enable Avista to maximize its use of the maximum rate and volume that would be available in the Clark Fork River.

Avista's water rights

1951: Rate: 35,000 cfs, Volume 25,338,843 acre-feet per year

1959: Rate: 5,400 cfs, Volume 3,909,421 acre-feet per year

1974: Rate rose to 50,000 cfs

Over a period of years (1951 to 1974), Avista continued to request more water from DNRC until the total reached 50,000 cfs. This rate is 2.5 times the average rate of flow of the Clark Fork River (20,000 cfs). Likewise, the water right for volume is 29 million acre- feet per year, which has never been available. The average yearly flow of the Clark Fork River is 14 million acre-feet, and the largest amount on record is about 20 million acre-feet. Avista likely analyzed peak flow data to compute the cost of additional

generation capacity against revenue from water it was spilling and sized its facility and water rights accordingly. The amount of water that Avista is now spilling, although significant, most likely is not worth the extra cost of more generation capacity.

Each request for additional rate and volume of water was approved without specifying the period of time when the rate was available. Since there is no detail in the water right certificate protecting water rights senior to Avista's water rights or future use of water for commercial or residential development in the Clark Fork basin, the possibility of a water call on junior users by Avista probably was not on the radar screen. Judge Holter in 1986 clarified the magnitude of the water rights and stated that "WWP continued to beneficially use all of the water that it appropriated to the extent that such water has been available in the Clark Fork River." He did not mention the fact that the 50,000 cfs was only available a few days a year and sometimes not at all or that the stated volume has never been available. Also, no mention was made regarding the possibility of a water call on junior water users as a result of the overstatement of volume and rate. Had this possibility been considered, language would certainly have been added to make sure that the interest of citizens of Montana would have been protected. Since Avista was not required to prove that the water was legally and physically available to meet its huge water right requests and no restrictive language was placed on Avista's water rights, does this mean that it is too late to correct this oversight? I think not, the final decree has not been done and the pre-1973 water rights have not been looked at. Historical use data must be considered as well as the operational efficiency of Avista. The impact of rain fall and snow pack in the Clark Fork River basin dwarfs impacts by water users.

6. Examining the 92 years of flow data over any averaging period one chooses—annual, monthly, or daily—average flows in the lower Clark Fork River have increased since Noxon Rapids Dam was built. One can, therefore, conclude that the flow data do not show any evidence that the water supply for Avista's dams is being negatively impacted and that no measurable negative impact on Avista's water rights occurs as a result of new water rights or farm and ranch land irrigation during the summer months or at any other time.

7. The calculations done on a daily basis are more accurate than the calculations that were done using monthly averages. Monthly averages mitigate high water flows during the month and therefore underestimate the rate of water flow into Avista on a daily basis. Since Avista has minimal storage capacity, it is considered to be a "run of the river" electricity generation facility. An analysis of the water flow from 1911 to 2000 reveals that water flows into Avista exceeds its capacity to generate (50,000 cfs) during April, May, June, and July, thus resulting in spills. Spills occur about 9 out of every 11 years or 82% of the time. This is assuming that Avista operates its dam to make maximum use of the water available.

8. Water for irrigation was part of the justification for building Hungry Horse Dam. USBR filed a water right of 500,000 acre-feet when Hungry Horse Dam was built to provide additional water for irrigation. It is unlikely that this water will be needed by irrigators because development is causing a net decrease in the amount of land being irrigated. However, this water should be available to the citizens of Montana for future development and not be diverted to other uses.

9. Spillage of 671,000 acre-feet at Avista indicates that more storage and/or irrigation are necessary to get maximum value from Avista's facilities. Avista should be encouraging reservoirs and other means of storage to be built and filled during peak flows. An additional reduction of spillage of 7% would most likely completely mitigate the entire amount used by junior water users.

10. Public relations are very important to out-of-state corporations doing business in Montana, especially when their product is sold out of state. The small amount of potential profit from a call or closing the

basin to new water rights would not be worth the ill will that would be generated by such actions. In Montana, people are generally good neighbors and share shortages rather than taking all they can get. In the case of Avista, the hydroelectric project got to the water supply early with the capacity to take it all. Avista may not consider sharing if its priority is solely on increasing profits without regard to other options. Montana's water may not have been adequately protected for use for the welfare and benefit of all of the people of the state as required by state law, but many options are available to prevent the end of economic development in western Montana that depends on water availability.

#### Subordination of Cabinet Gorge's Water Rights

When Washington Water Power began to construct the Cabinet Gorge hydropower facility across the Montana border in Idaho on the Clark Fork, the Montana Legislature wanted to ensure that the state's ability to use water in Montana would not be limited by an out-of-state water use. In 1951, the Montana Legislature passed a law (Montana Annotated Code 85-1-122. Clark Fork River) stipulating that the waters of the Clark Fork River may be impounded or restrained within the state of Montana for a distance not exceeding 25 miles from the Idaho-Montana boundary line by a dam located on said river in the state of Idaho and constructed by any person, firm, partnership or corporation authorized to do business in the state of Montana. Any present or future appropriation of water in the watershed in the state of Montana for irrigation and domestic use above said dam shall have priority over water for power use at said dam.

This language subordinates any Montana water right held by WWP at Cabinet Gorge (36,000 cfs and 26,062,410 acre-feet per year with a priority date of 1951) to future irrigation and domestic water uses upstream of the dam. Cabinet Gorge Dam is located in Idaho, but 98% of the reservoir behind the dam is located in Montana. This same provision was not enacted when Noxon Rapids was built at about the same time. The State of Idaho has a preference clause in its water right statute that places hydropower at the bottom of the preference list.

#### **Analysis Presented by Steve Fry**

In response to Rep. Jackson's analysis, Steve Fry presented data to demonstrate that depending on how the flow data are analyzed, one might reach different conclusions about impacts on Avista's water rights. He argued that river flows in cfs and the timing of those flows are important hydropower parameters. Figure A4-4 shows the USGS daily flow record at Plains from 1954 to 2002. Over this period, Mr. Fry's analysis showed that the average daily flow dropped by about 4,600 cfs, indicating an adverse effect on Avista's water rights and use. Figures A4-5 and A4-6 show the average monthly June flows at Plains for 1911-1954 and 1955-2002, respectively. The average June flows declined through both periods, but the rate of the decline was greater in the 1955-2002 period after construction of Noxon Rapids Dam. Figures A4-7 and A4-8 show the average monthly July flows at Plains for 1911-1954 and 1955-2002. Again, Mr. Fry found that the average monthly flows declined through both periods.



**Table A4-3**  
**USGS CLARK FORK at Polson 1911-2000**

<b>Year</b>	<b>Avg Annual (AF)</b>		
1911	7,984,607		
1912	7,389,849		
1913	9,713,128		
1914	7,130,394		
1915	5,859,483		
1916	11,874,254		
1917	8,719,174		
1918	8,819,944		
1919	6,114,458		
1920	7,072,883	<b>8,067,817</b>	<b>10 year avg (AF)</b>
1921	9,860,139		
1922	7,728,506		
1923	8,450,317		
1924	7,293,750		
1925	11,154,441		
1926	6,196,210		
1927	Incomplete Data		
1928	Incomplete Data		
1929	6,402,635		
1930	6,148,334	<b>7,904,292</b>	<b>10 year avg (AF)</b>
1931	5,390,085		
1932	8,991,475		
1933	11,119,581		
1934	10,319,817		
1935	7,904,423		
1936	6,867,666		
1937	5,922,158		
1938			

	7,040,490		
1939	7,303,974		
1940	4,930,317	<b>7,578,999</b>	<b>10 year avg (AF)</b>
1941	4,424,785		
1942	7,262,680		
1943	9,934,296		
1944	4,070,462		
1945	6,411,355		
1946	9,093,849		
1947	10,382,898		
1948	9,405,388		
1949	7,456,690		
1950	11,219,199	<b>7,966,160</b>	
1951	11,418,238		
1952	7,776,634		
1953	7,043,597		
1954	10,221,441		
1955	8,265,037	<b>7,646,423</b>	<b>45 Year Avg (AF)</b>
1956	10,646,636		
1957	7,879,115		
1958	6,264,276		
1959	12,584,013		
1960	9,075,477	<b>9,117,446</b>	<b>10 year avg (AF)</b>
1961	9,328,839		
1962	8,237,772		
1963	7,279,480		
1964	9,987,868		
1965	11,098,528		
1966	8,924,971		
1967			

	9,238,337		
1968	7,977,608		
1969	9,547,837		
1970	7,695,058	<b>8,931,630</b>	<b>10 year avg (AF)</b>
1971	10,457,429		
1972	10,357,232		
1973	6,078,354		
1974	12,055,822		
1975	8,921,999		
1976	9,448,311		
1977	5,468,944		
1978	8,222,249		
1979	7,593,326		
1980	6,607,013	<b>8,521,068</b>	<b>10 year avg (AF)</b>
1981	9,199,124		
1982	8,395,717		
1983	8,174,004		
1984	7,062,874		
1985	8,042,938		
1986	7,584,152		
1987	6,251,276		
1988	5,695,417		
1989	7,819,935		
1990	9,834,498	<b>7,805,994</b>	<b>10 year avg (AF)</b>
1991	10,909,958		
1992	5,989,445		
1993	7,274,518		
1994	5,577,454		
1995	7,281,404		
1996	11,959,390		

1997	11,710,464		
1998	6,841,336		
1999	7,920,202		
2000	7,336,223	9,263,489	8,485,263
45 year avg (AF)			
		8,065,843	90 year avg (AF)

**Table A4-4**  
**USGS CLARK FORK at St. Regis 1911-2000**

Year	Avg Annual (AF)		
1911	No Data		
1912	6,655,491		
1913	7,578,961		
1914	5,319,918		
1915	4,093,403		
1916	8,389,799		
1917	8,174,456		
1918	7,547,604		
1919	3,668,233		
1920	5,578,513	6,334,042	10 Year Avg
1921	6,084,776		
1922	5,724,384		
1923	Incomplete Data		
1924	Incomplete Data		
1925	Incomplete Data		
1926	Incomplete Data		
1927	Incomplete Data		
1928	Incomplete Data		
1929	3,599,551		
1930	3,978,612	4,846,831	10 Year Avg
1931	2,419,619		
1932	4,464,179		
1933	6,214,604		
1934	5,997,931		
1935	3,743,974		
1936	4,130,504		
1937	2,627,244		
1938	5,004,927		

1939	3,771,906			
1940	3,033,309	<b>4,140,820</b>	<b>10 Year Avg</b>	
1941	2,777,390			
1942	4,516,954			
1943	7,265,555			
1944	3,097,324			
1945	3,859,440			
1946	4,790,032			
1947	6,659,560			
1948	7,774,708			
1949	5,496,229			
1950	7,056,968	<b>5,329,416</b>	<b>10 Year Avg</b>	
1951	7,155,762			
1952	5,384,624			
1953	5,171,966			
1954	6,064,972			
1955	5,405,853		<b>4,450,650</b>	<b>45 Year Avg</b>
1956	7,137,866			
1957	5,252,762			
1958	5,460,420			
1959	7,144,280			
1960	4,879,722	<b>5,905,823</b>	<b>10 Year Avg</b>	
1961	4,625,557			
1962	5,735,058			
1963	4,838,865			
1964	6,258,752			
1965	7,644,736			
1966	4,088,397			
1967	6,135,278			
1968	5,408,077			
1969	6,006,449			
1970	5,625,382	<b>5,636,655</b>	<b>10 Year Avg</b>	
1971	7,021,331			
1972	7,943,683			
1973	2,926,311			
1974	7,337,518			

1975	7,436,781			
1976	7,602,564			
1977	2,603,383			
1978	5,985,574			
1979	4,623,258			
1980	5,616,141	<b>5,909,654</b>	<b>10 Year Avg</b>	
1981	5,527,140			
1982	7,167,604			
1983	4,687,313			
1984	5,242,100			
1985	4,218,348			
1986	5,140,628			
1987	2,802,379			
1988	2,994,966			
1989	4,601,100			
1990	4,786,143	<b>4,716,772</b>	<b>10 Year Avg</b>	
1991	4,790,032			
1992	2,918,415			
1993	4,104,350			
1994	3,149,533			
1995	5,133,148			
1996	7,419,561			
1997	8,472,677			
1998	4,861,397			
1999	5,522,964			
2000	3 722,095	<b>5,480,310</b>	<b>5,389,396</b>	<b>45 Year Avg</b>
		<b>4,920,023</b>	<b>90 year avg</b>	

**Table A4-5**

**USGS CLARK FORK at Plains 1911-2000**

Year	Avg Annual (AF)
1911	13,935,095
1912	13,766,340
1913	17,40,5335

1914	12,940,621		
1915	10,972,214		
1916	20,25,4893		
1917	17,490,665		
1918	17,160,460		
1919	10,340,607		
1920	13,481,240	<b>14,774,767</b>	<b>10 Year Avg</b>
1921	15,922,216		
1922	13,946,502		
1923	14,158,061		
1924	11,526,364		
1925	17,698,038		
1926	10,024,788		
1927	20,293,339		
1928	19,481,230		
1929	10,368,890		
1930	10,355,970	<b>14,377,540</b>	<b>10 Year Avg</b>
1931	7,909,706		
1932	14,126,336		
1933	17,794,062		
1934	16,655,140		
1935	12,043,437		
1936	11,563,446		
1937	8,904,145		
1938	12,46,3344		
1939	11,393,878		
1940	8,190,419	<b>12,106,391</b>	<b>10 Year Avg</b>
1941	7,303,190		
1942	12,092,690		
1943	17,627,312		
1944	7,449,142		
1945	10,510472		
1946	14,203,578		
1947	17,718,957		
1948	17,945,962		
1949	13,517,236		
1950	18,736,398	<b>13,730,494</b>	<b>10 Year Avg</b>
1951	18,837,284		
1952	13,414,817		

1953	12,671,042			
1954	16,535,049			
1955	14,202,263		<b>13,901,164</b>	<b>45 Year Avg</b>
1956	18,915,457			
1957	13,920,319			
1958	12,658,704			
1959	20,484,328			
1960	14,487,684	<b>13,564,270</b>	<b>10 Year Avg</b>	
1961	14,472,818			
1962	14,626,494			
1963	12,543,472			
1964	16,773,154			
1965	19,222,868			
1966	13,285,125			
1967	15,870,411			
1968	14,013,430			
1969	16,623,405			
1970	14,289,981	<b>15,172,116</b>	<b>10 Year Avg</b>	
1971	18,227,999			
1972	19,366,220			
1973	9,348,542			
1974	20,161,548			
1975	17,004,636			
1976	17,737,036			
1977	8,358,136			
1978	15,187,038			
1979	13,218,500			
1980	13,424,493	<b>15,203,415</b>	<b>10 Year Avg</b>	
1981	15,829,504			
1982	16,090,019			
1983	13,286,984			
1984	12,781,949			
1985	12,988,859			
1986	13,694,753			
1987	9,665,463			



1988	9,232,653			
1989	13,195,207			
1990	15,418,159	13,218,355	10 Year Avg	
1991	16,430,119			
1992	9,331,744			
1993	12,212,204			
1994	9,254,797			
1995	12,996,423			
1996	20,186,811			
1997	21,173,467			
1998	12,335,687			
1999	13,963,423			
2000	11,259,636	15,456,247	14,567,770	45 Year Avg
		14,234,467	90 year avg	

Table A-6

YEAR	USGS		CLARK FORK NEAR PLAINS			Jun	ft <sup>3</sup> /s	Aug	Sep	Oct	Nov	Dec
	Jan	Feb	Mar	Apr	May		Jul					
1911	8,008	8,443	8,073	17,000	44,100	84,000	35,800	14,360	9,585	9,517	7,772	6,450
1912	5,500	6,001	5,855	15,520	49,290	65,200	32,390	13,080	10,060	8,839	9,035	7,500
1913	7,362	7,943	7,026	18,820	53,930	98,150	42,820	16,980	10,080	8,735	9,065	8,042
1914	7,410	7,358	8,589	16,870	48,900	48,150	23,810	10,600	8,480	9,825	14,180	9,509
1915	7,971	7,352	7,175	15,470	31,160	35,370	26,529	14,380	9,958	9,361	8,560	8,655
1916	6,504	6,400	15,210	29,199	52,080	80,730	78,930	24,840	15,340	12,000	9,000	7,200
1917	8,200	6,700	6,200	13,800	54,930	91,870	55,340	17,670	9,907	8,189	7,386	11,580
1918	21,340	12,980	12,570	26,100	56,570	73,330	32,629	15,709	10,310	8,658	7,967	6,673
1919	6,180	6,316	5,647	15,160	42,580	46,740	18,390	9,171	6,017	5,100	5,202	4,150
1920	5,030	5,550	8,282	10,720	43,130	61,739	37,690	14,040	9,591	11,160	9,758	8,647
1921	8,388	8,507	11,820	20,720	60,629	80,780	31,530	12,240	8,002	8,812	6,794	8,137
1922	6,981	5,641	6,220	10,570	46,690	86,870	26,140	12,380	8,706	6,972	6,561	5,867
1923	6,792	6,075	6,717	14,620	49,870	73,300	34,780	13,800	8,257	7,269	6,928	6,365
1924	5,806	6,760	8,528	10,830	55,920	46,560	21,330	10,420	6,643	6,390	6,750	7,000
1925	8,420	12,600	10,500	37,360	75,730	69,390	32,629	13,710	10,910	8,424	7,250	7,000
1926	6,358	6,822	7,749	19,270	39,670	22,770	12,150	6,500	7,300	11,080	12,210	14,340
1927	9,583	8,416	9,171	13,840	55,240	100,800	52,810	18,260	14,249	15,100	21,170	17,940
1928	13,500	11,210	14,040	20,740	89,760	73,980	44,400	18,870	10,940	9,245	8,564	7,380
1929	5,481	4,971	6,485	8,425	34,690	57,340	24,250	9,249	6,675	5,330	4,823	5,164
1930	4,336	6,035	5,782	22,750	41,380	39,060	18,080	8,461	6,332	6,932	6,831	5,919
1931	5,195	5,062	5,548	9,197	35,120	32,440	13,250	6,148	4,768	4,760	4,764	4,932
1932	4,640	5,286	8,301	19,460	59,340	64,040	31,200	11,780	7,483	6,022	8,003	8,663
1933	7,388	6,054	6,424	11,330	42,640	99,770	45,210	14,879	9,317	10,170	20,630	21,430
1934	22,320	16,390	17,850	47,830	59,540	46,400	17,920	9,031	5,718	6,031	9,337	8,665
1935	7,835	8,053	7,990	11,460	41,110	61,829	29,530	11,500	6,533	5,341	4,672	4,224
1936	4,083	4,231	6,923	20,040	63,300	49,720	16,520	7,710	5,734	5,010	4,588	4,074
1937	3,343	3,940	4,636	6,112	32,629	44,430	21,960	9,092	5,380	5,014	5,218	5,825
1938	5,769	5,354	6,289	16,780	48,050	65,810	22,560	8,606	9,662	7,904	6,074	6,087
1939	7,715	7,984	8,260	19,150	58,780	38,590	14,630	7,000	7,325	7,257	6,278	6,000
1940	6,034	6,264	7,073	16,230	36,090	24,900	7,843	5,845	5,899	7,137	6,655	6,034
1941	7,815	7,881	5,962	9,377	13,010	19,380	8,840	6,150	7,215	8,492	10,590	15,980
1942	17,440	8,964	7,796	17,150	37,500	45,970	23,090	9,894	7,655	7,286	8,136	9,697
1943	12,330	13,250	10,260	39,530	52,240	77,660	40,950	11,830	10,600	10,680	9,356	7,793
1944	7,068	6,320	7,048	8,014	19,250	28,790	11,770	7,165	6,729	7,193	7,337	7,157

YEAR	USGS CLARK FORK NEAR PLAINS						ft <sup>3</sup> /s	Aug	Sep	Oct	Nov	Dec
	Jan	Feb	Mar	Apr	May	Jun	Jul					
1945	8,486	8,516	8,639	8,401	31,850	51,570	18,820	5,633	6,593	7,341	7,901	9,991
1946	11,220	11,960	11,620	21,530	54,479	50,270	19,770	9,050	8,107	9,695	10,760	17,400
1947	13,789	15,100	15,060	24,820	79,930	60,610	21,740	9,969	9,051	16,650	14,810	12,640
1948	14,490	12,950	10,020	19,540	72,230	101,600	21,180	13,380	8,426	7,795	8,037	8,742
1949	13,860	9,111	9,283	19,720	67,260	44,520	14,170	7,844	6,269	9,315	10,670	12,200
1950	11,940	13,100	12,230	17,350	43,950	81,800	51,290	16,030	8,862	12,709	15,340	16,630
1951	19,150	19,010	14,879	25,090	73,860	61,100	36,080	12,360	10,860	14,820	13,910	11,560
1952	12,630	15,409	10,120	23,810	61,250	36,600	17,890	7,877	7,988	9,493	9,933	9,898
1953	10,750	9,940	9,833	10,920	27,110	64,870	25,760	8,776	10,160	10,690	10,890	11,140
1954	8,756	13,250	13,270	17,990	55,889	57,630	43,690	13,260	10,210	11,020	13,260	16,070
1955	15,960	16,310	12,270	12,640	27,170	50,490	36,420	10,790	11,570	12,220	13,120	17,230
avg	9,258	8,879	9,047	18,028	49,552	59,731	28,767	11,454	8,650	8,778	9,251	9,417
1956	15,910	16,440	19,350	37,390	66,350	66,890	24,950	9,451	11,780	13,080	15,129	17,770
1957	16,160	13,850	13,780	12,450	53,069	45,410	15,010	7,486	9,199	12,889	16,610	15,350
1958	10,280	9,044	11,550	12,980	50,270	42,520	18,280	6,309	8,471	9,204	11,520	19,480
1959	21,230	20,700	15,970	33,340	50,940	79,860	33,270	10,580	13,440	23,550	20,050	18,070
1960	14,660	15,300	20,730	35,100	38,430	50,280	22,490	9,397	7,911	8,145	8,730	10,300
1961	10,230	12,540	17,080	23,570	49,590	64,290	15,330	6,804	7,978	10,870	9,149	13,500
1962	18,350	21,960	10,120	24,970	50,520	46,510	20,550	8,630	6,757	9,438	11,330	16,590
1963	16,920	19,190	15,590	20,460	28,670	42,600	23,220	7,488	6,798	8,929	7,963	11,400
1964	13,270	15,620	16,030	13,220	35,410	90,860	33,470	10,560	10,750	10,640	13,289	16,310
1965	15,660	21,750	25,610	31,720	55,820	68,430	29,149	13,440	14,240	13,630	12,950	15,950
1966	15,650	17,300	14,020	18,720	31,350	42,750	20,150	7,319	11,760	15,850	14,870	11,670
1967	13,480	15,320	15,740	14,900	40,190	77,610	25,580	9,009	9,814	12,440	13,080	17,110
1968	17,670	12,860	15,530	15,140	26,970	50,370	20,350	10,210	15,600	16,080	16,490	15,930
1969	18,050	19,040	18,980	36,520	55,279	37,660	24,450	13,320	14,190	14,510	11,650	12,860
1970	11,120	9,678	11,090	13,940	42,640	61,410	21,930	12,000	13,630	14,570	10,620	14,690
1971	16,470	21,880	15,170	24,080	65,850	66,070	28,630	11,960	10,880	12,640	13,780	15,870
1972	16,460	15,580	25,720	31,000	57,840	83,330	29,120	12,060	10,410	12,559	13,460	14,770
1973	14,778	15,070	12,960	10,990	18,710	22,350	13,960	8,286	5,754	9,211	11,670	12,080
1974	19,790	19,130	21,930	33,610	50,890	86,570	39,840	13,830	10,280	11,280	14,320	14,230
1975	15,210	12,280	10,560	10,600	31,920	79,520	40,170	15,380	13,050	16,210	16,870	20,670
1976	17,210	18,180	16,890	28,770	67,590	50,130	30,669	15,120	11,050	11,090	13,330	13,610
1977	14,670	10,940	8,977	8,705	15,370	13,580	9,466	9,145	8,334	12,640	13,990	13,160

YEAR	USGS CLARK FORK NEAR PLAINS						ft <sup>3</sup> /s	Aug	Sep	Oct	Nov	Dec
	Jan	Feb	Mar	Apr	May	Jun	Jul					
1978	14,330	13,619	12,670	23,210	36,400	51,649	31,319	11,240	12,270	13,630	15,989	15,960
1979	15,950	12,190	10,150	14,399	46,510	41,500	18,200	10,960	9,901	11,180	14,630	13,790
1980	10,930	9,234	8,057	14,040	45,320	50,649	20,820	9,125	11,930	13,690	13,740	17,180
1981	17,060	17,840	14,910	17,380	48,080	63,800	26,790	9,029	9,371	14,390	13,270	11,520
1982	13,980	15,409	14,330	19,470	47,910	65,130	38,440	11,440	9,370	10,300	10,740	10,950
1983	15,350	15,350	13,400	16,310	29,600	35,120	28,699	11,480	13,150	14,549	14,760	12,980
1984	16,740	14,090	13,270	15,750	24,010	44,880	20,110	10,170	12,470	14,050	13,250	14,030
1985	14,199	13,189	10,680	16,920	35,330	35,250	13,410	13,289	16,920	16,030	16,230	14,540
1986	15,380	17,910	22,020	26,929	30,680	41,950	13,850	7,612	12,730	13,480	14,040	13,120
1987	12,670	11,060	9,408	15,590	27,270	15,390	9,715	8,813	13,300	12,889	11,580	11,760
1988	7,959	11,510	15,590	19,510	22,190	21,210	9,733	5,656	6,291	9,958	12,560	11,770
1989	8,416	10,170	12,580	21,750	35,750	36,510	18,190	14,750	16,150	12,450	15,190	17,350
1990	16,560	12,850	13,510	29,990	34,480	56,189	25,470	10,510	11,170	14,598	16,010	15,190
1991	16,710	19,400	17,030	21,570	44,790	55,279	31,510	10,350	12,230	14,640	15,190	14,770
1992	12,640	9,483	10,030	14,249	19,950	18,270	12,000	9,738	11,610	14,460	12,180	10,480
1993	16,120	10,280	11,150	12,460	32,040	28,470	24,360	11,770	12,320	12,280	14,729	18,510
1994	16,600	12,670	10,480	16,039	24,720	21,280	9,375	5,891	5,551	8,954	13,460	9,140
1995	10,140	15,000	13,339	12,410	19,150	48,020	23,590	10,360	9,205	11,780	17,770	27,630
1996	20,830	30,070	31,390	41,330	51,770	66,470	27,070	16,530	11,100	10,500	15,140	14,929
1997	16,670	17,440	18,990	29,290	76,280	85,120	30,070	17,740	12,600	12,240	17,770	16,750
1998	12,350	9,459	9,719	13,089	30,440	41,380	27,889	13,660	10,530	9,584	14,940	11,740
1999	11,570	10,580	13,830	19,190	31,910	52,100	27,200	13,420	9,644	8,464	16,200	17,890
2000	14,470	11,080	11,810	22,000	31,480	30,490	16,760	9,010	7,282	8,325	11,290	12,210
45-avg	14,889	14,968	14,912	21,001	40,218	50,540	23,214	10,694	10,870	12,508	13,812	14,746

YEAR	USGS CLARK FORK NEAR PLAINS											
	Jan	Feb	Mar	Apr	May	Jun	ft <sup>3</sup> /s Jul	Aug	Sep	Oct	Nov	Dec
10-avg	14,817	14,585	14,889	20,239	36,612	45,038	23,003	11,742	10,267	11,339	14,771	15,163
10-acft	881,473	867,687	885,751	1,204,013	2,178,024	2,679,314	1,368,477	698,535	610,814	674,538	878,725	902,056

#### 1911-1955 Monthly averages

ft <sup>3</sup> /s	9,259	8,879	9,047	18,028	49,552	59,731	28,767	11,454	8,550	8,804	9,318	9,442
acre-ft	550,793	528,230	538,214	1,072,479	2,947,830	3,553,401	1,711,342	681,384	508,632	523,775	554,337	561,702

#### 1956-2000 Monthly averages

ft <sup>3</sup> /s	14,889	14,968	14,912	21,001	40,218	50,540	23,214	10,694	10,870	12,508	13,812	14,746
acre-ft	885,731	890,428	887,102	1,249,356	2,392,540	3,006,606	1,381,019	636,169	646,685	744,123	821,660	877,225

#### Average of two 45 year periods

	12,074	11,924	11,979	19,515	44,885	55,135	25,991	11,074	9,710	10,656	11,585	12,094
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#### Percent of Change between two 45 periods

	61%	69%	65%	16%	-19%	-15%	-19%	-7%	27%	42%	48%	56%
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#### Percent of Change between 1st 45 yr ave & Last 10 yr ave

	60%	64%	65%	12%	-26%	-25%	-20%	3%	20%	29%	59%	61%
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#### Difference between two 45 periods

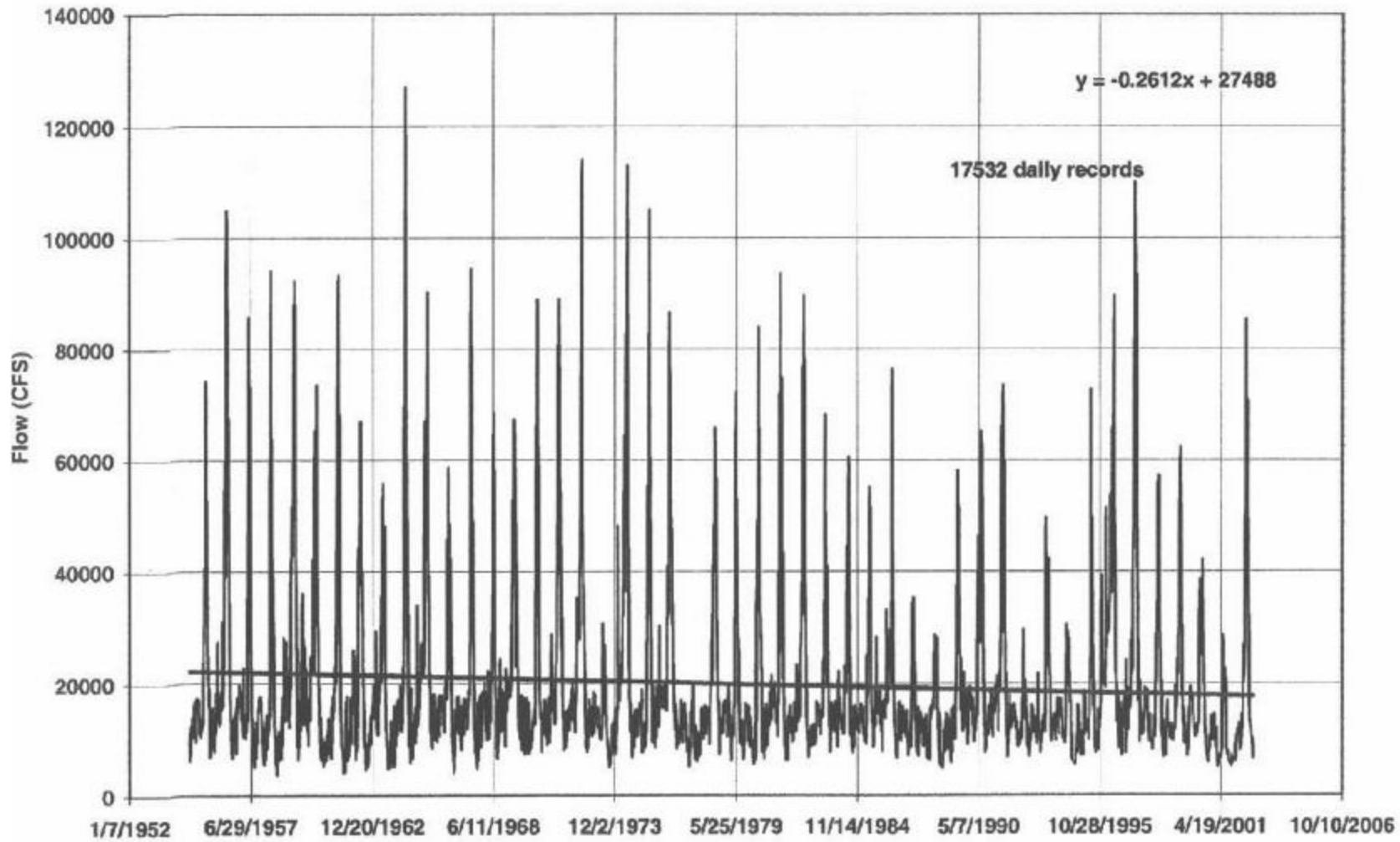
ft <sup>3</sup> /s	5,630	6,088	5,865	2,973	-9,334	-9,191	-5,553	-760	2,321	3,704	4,494	5,304
acre-ft	334,938	362,198	348,888	176,877	-555,290	-546,795	-330,323	-45,215	138,054	220,349	267,323	315,523

#### Difference between 1st 45 yr. ave & last 10yr ave

acre-ft	330,680	339,457	347,537	131,534	-769,806	-874,087	-342,865	17,152	102,182	150,763	324,388	340,354
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## Appendix A4-4

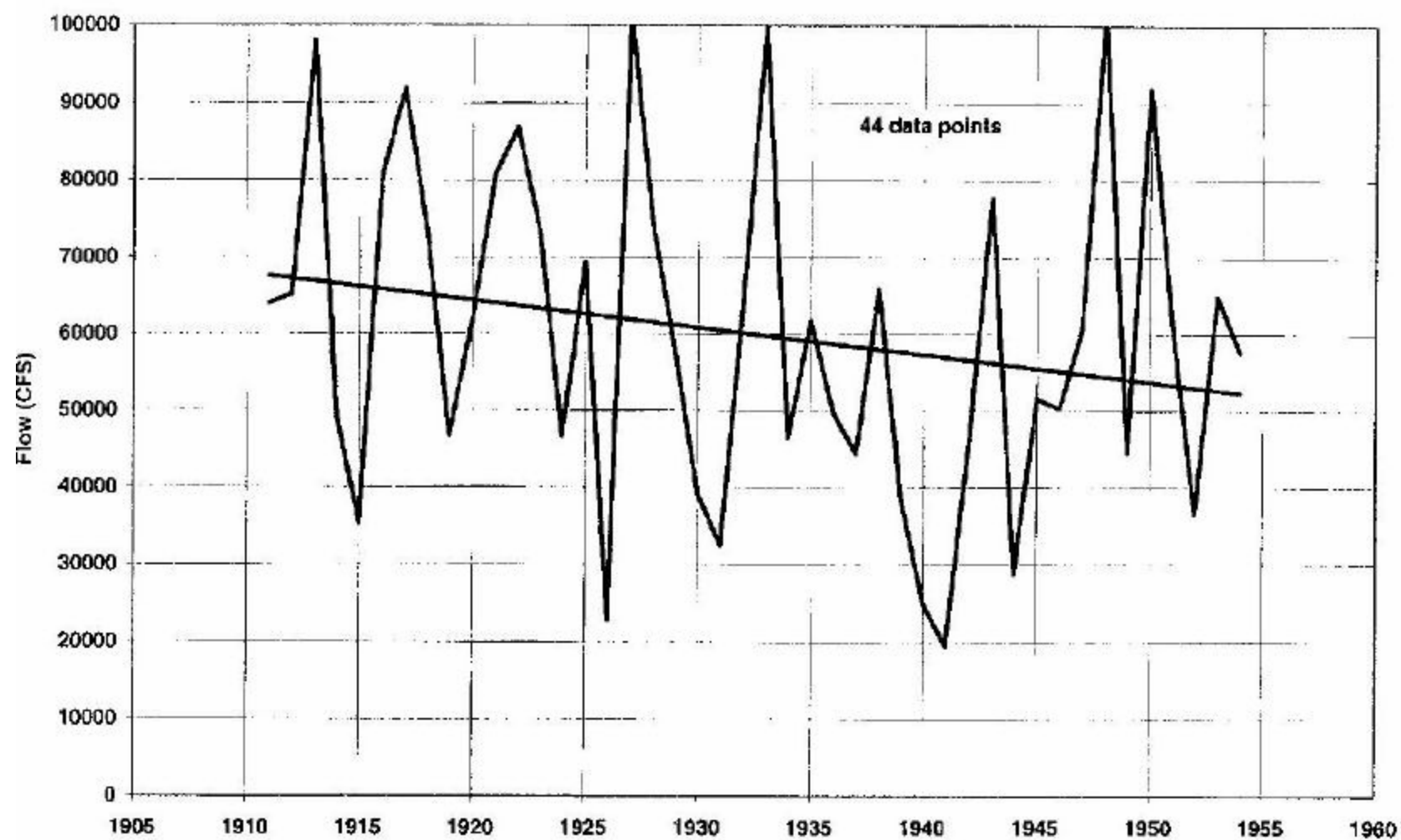
Clark Fork at Plains  
Daily Flow Record 1954 -- 2002  
Slope of the trendline = 4579 cfs decline



## Appendix A4-5

Clark Fork at Plains  
Average Monthly June Data - 1911 to 1954

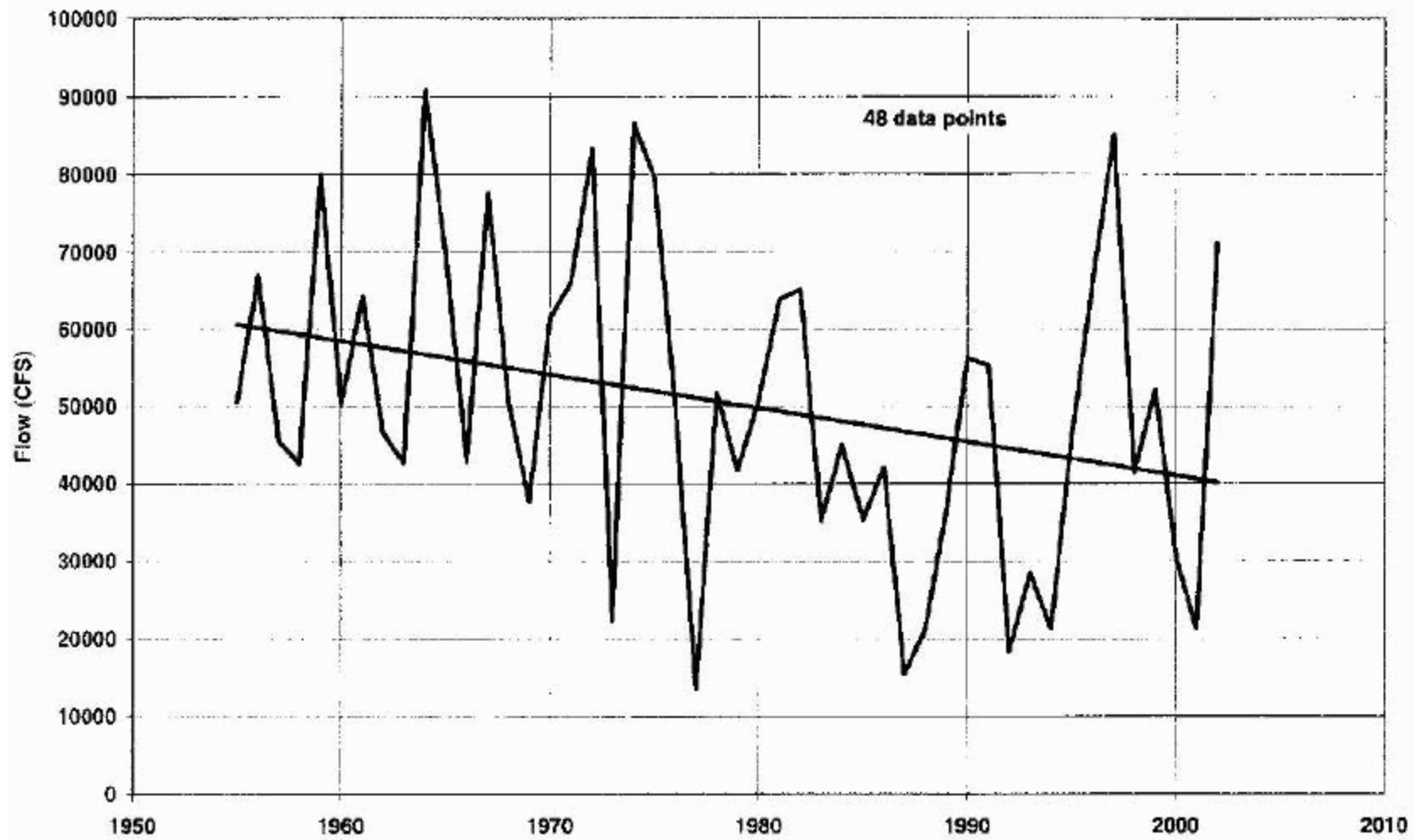
$$y = -354.84x + 745663$$



Appendix A4-6

Clark Fork at Plains  
Average Monthly June Data – 1955 to 2002

$$y = -436.21x + 913400$$

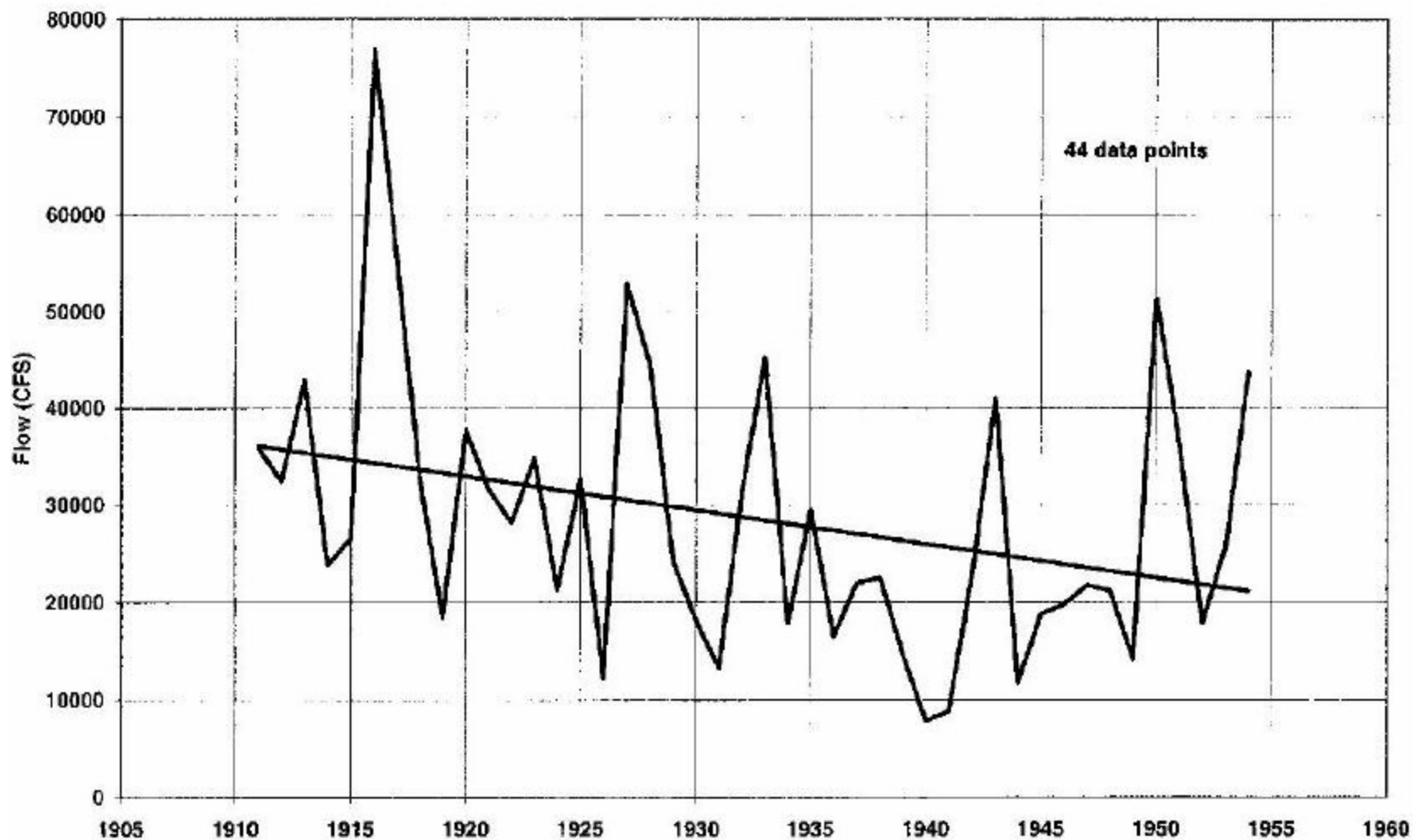


Appendix A4-7



Clark Fork at Plains  
Average Monthly July Data – 1911 to 1954

$$y = -347.27x + 699691$$



Appendix A4-8

Clark Fork at Plains  
Average Monthly July Data -- 1955 to 2002

$$y = -97.117x + 215521$$

